THE DIGESTIVE SYSTEM OF THE EEL-POUT (*ZOARCES ANGUILLARIS*).

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A systematic examination of the digestive system and its function in fishes, at different levels on the evolutionary scale, may greatly aid in the understanding of the digestive processes in higher animals, and in addition may shed some light on the relation between certain fish and other marine forms: a problem interesting from a theoretical as well as a practical point of view.

In the present study an attempt has been made to investigate the functions of the digestive system of the eel-pout (*Zoarces Anguillaris*) found in the Bay of Fundy. As no description of the alimentary tract and its appendages could be found in the literature available, a few macroscopical dissections were made in order to show the anatomical relations existing in the eel-pout. The drawings presented in this paper are all done from a single specimen, which measured 425 mms. from the snout to tip of the caudal fin.

The alimentary canal in the eel-pout is comparatively short and presents an œsophagus, stomach and intestine, of which the latter may be separated into a duodenum and small intestine. On opening the abdomen the ventral surfaces of the viscera are seen *in situ* (Fig. 1). The stomach, partially obscured by the liver, lies on the left side; during fasting this viscus is rather small, but in fed animals it may become tremendously distended. Pyloric cæca are absent, but there is a well-marked sphincter separating the stomach from the pear-shaped duodenum. The latter structure occupies a mid-ventral position from whence it curves posteriorly and to the right, gradually tapering into the small intestine. The intestine is bent upon itself to form three limbs—an ascending, transverse and descending—which latter limb passes posteriorly to the rectum. In Fig. 2 the empty ali-

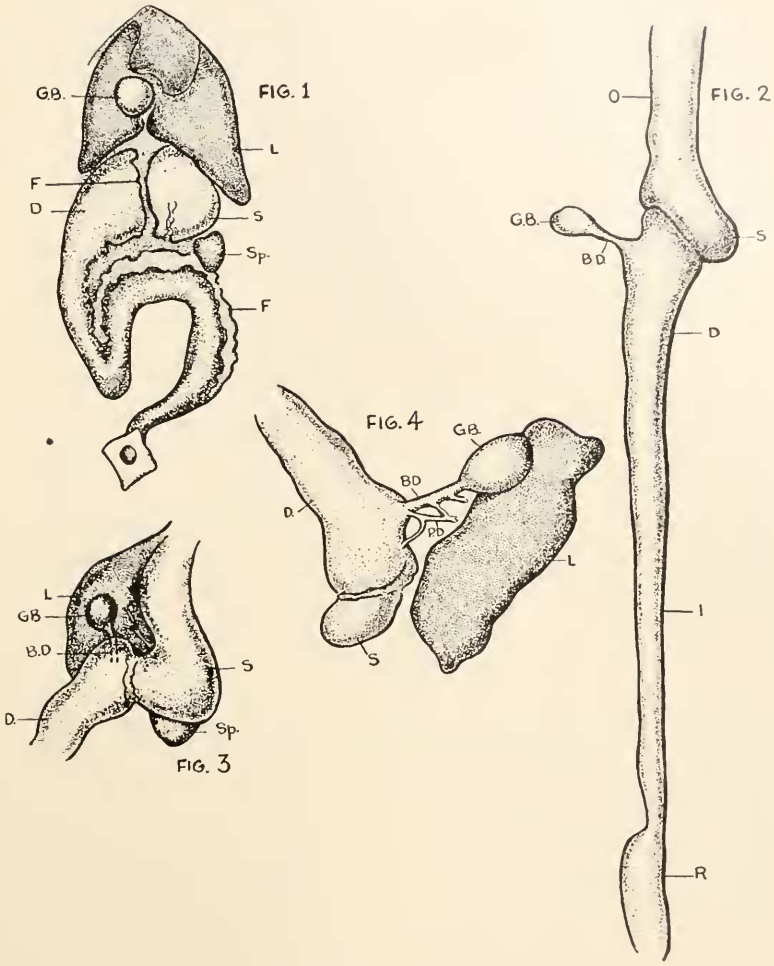

FIG. 1. Diagram of the alimentary tract *in situ*.

FIG. 2. Scheme of the alimentary tract, dissected free from surrounding structures.

FIG. 3. Shows the entrance of the bile duct into the duodenum.

FIG. 4. Diagram to show the pancreatic duct entering the duodenum in close relation to the bile duct. *L.* Liver; *G.B.* Gall bladder; *B.D.* Bile duct; *P.D.* Pancreatic duct; *Sp.* Spleen; *F.* Fat; *O.* Œsophagus; *S.* Stomach; *D.* Duodenum; *I.* Intestine; *R.* Rectum.

mentary canal dissected free from surrounding structures is stretched out to show the length of the various portions and their relation to each other.

The liver is a large three-lobed organ which occupies an anterior ventral position in the abdomen, the left lobe obscuring the œsophagus and part of the stomach, while the tip of the right lies behind the duodenum. Between these lobes is situated the large gall bladder, which in the specimen examined had a body length of 14 mms. by 10 mms. and was drained by a duct of 8 mms. (Figs. 4 and 1). This duct pierced the duodenum on its anterior dorsal surface a few mms. below the pyloric sphincter (Figs. 2 and 3). No special microscopic examination was made for pancreatic tissue, but it appears that the pancreatic duct joins the bile duct or enters the duodenum close to it (Fig. 4).

According to Krüger (1), in a closely related species *Zoarces viviparus*, the pancreas is diffused amongst the fatty tissue situated in the loops of the small intestine and forms pancreatic threads which lie in the groove between the stomach and the duodenum, and also cover the short bile duct. The opening from the pancreatic gland, in this species, is combined with the bile duct, but does not empty into it.

Methods.

The reaction of the stomach, duodenum and bile in the eel-pout and other fishes was measured by the "spot" method described by Felton (2). This method was very satisfactory for the purpose, as it required only a few drops of fluid for a determination. The values obtained from it, however, can only be considered as approximate, as a protein and salt error was frequently introduced by the presence of mucus or partially digested food in the sample under investigation.

To study the digestive enzymes in the eel-pout, extracts were made of different parts of the alimentary tract. The method of making these extracts was as follows: The mucous membrane was washed in running water, scraped off from the muscular layers and made into a brew consisting of 50 per cent. tissue, 50 per cent. extracting substance and toluene. The mixture was allowed to stand for two days at room temperature, after which it was filtered before adding to the substrate. Saline, 30 per cent. alcohol, and glycerol were all used for extracting substances, but were not all equally effective, the alcoholic extract yielding

the most active amylase and lipase, while glycerol only extracted a protease. The latter enzyme was rather weak and difficult to obtain under any of the observed conditions.

In the experiments to test the presence of an amylase, 2–4 drops of the filtered enzyme extract were added to 2 cc. 5 per cent. soluble starch, the P_H adjusted between 6.6 and 7.0 and the whole incubated at 37° C. During the incubation, the mixture was tested occasionally with iodine to ascertain how the digestion was proceeding, and at the end of two days a quantitative sugar determination was carried out by the Folin-Wu method (3) for blood sugar.

For lipase determinations the method of Anrep Lush and Palmer (4) was used. Three drops of the enzyme extract were added to a solution of glycerol triacetate buffered at a P_H 8.0. The time was taken which was required for the enzyme to turn the solution to a P_H 7.0 at room temperature. Changes in reaction were observed by noting the color changes in an indicator which had been added, at the beginning, to the mixture.

Both the amylase and lipase experiments were controlled by comparing with similar experiments in which the extracts had been previously boiled for 10 minutes.

A quantitative method was not used for the estimation of a protease. The presence of this enzyme was determined by the digestive action of the extract on protein. For this purpose fibrin was obtained from fresh blood and kept in glycerol, being thoroughly washed, and dried between filter paper, before using. Small shreds were then placed in three tubes, each containing some of the extract to be tested, and their reaction adjusted to a P_H 2.0, P_H 6.8 and P_H 8.0 respectively. These mixtures were incubated at 37° C. and the time noted which was taken to digest the fibrin.

Experimental data

The Reaction in the Alimentary Tract of the Eel-Pout under Different Conditions.—Investigations to determine the reaction of the stomach and duodenum were carried out on a large number of eel-pouts. These determinations were made, either immediately after the fish had been hooked on the trawl or after they had been kept in a tank or cage for several days without food.

Thus, it was possible to study the reaction in the alimentary canal under different conditions in both fasting and fed animals. In the Bay of Fundy the eel-pouts live chiefly on mytilus, periwinkles, scallops, barnacles, sea urchins and occasionally fish; they will, however, bite herring as readily as clam bait.

To obtain a sample for a P_H determination, the abdomen was first opened by a mid-line incision, the alimentary tract removed intact, and a ligature placed between the stomach and duodenum to prevent the passage of fluid from one to the other during the manipulations. A few drops of the contents were then sucked out by a pipette and were diluted 2–4 times before measuring the P_H. If the fish under examination was in a starving condition and the alimentary tract empty, the mucous membrane was washed with a few drops of distilled water on which the P_H was subsequently determined.

The following table shows the reaction of the stomach, duodenum and bile under different conditions.

Table I.

Reaction of the Stomach, Duodenum and Bile in the Eel-Pout.

A. Stomach Empty.

Fish Number.	Stomach.		Duodenum.		Bile.	
	Contents.	P_H.	Contents.	P_H.	Color.	P_H.
10	Empty	7.0	Empty	8.0	Greenish yellow	5.8
13	Empty	5.8	Yellow mucus	6.8–8.4 small intest.	Greenish yellow	5.6
14	Empty	7.0	Empty	6.4	Greenish yellow	5.4
19	Empty	8.6	Fluid and mucus	7.0	Greenish yellow	5.8
27	Empty	6.5	Empty	8.4	Light greenish yellow	5.4

B. Stomach, Fluid Contents Only.

9	Yellow fluid	7.4	Clear fluid	7.7	Greenish yellow	5.8
25	Yellow fluid	8.2	Yellow fluid	8.2	Dark greenish yellow	5.8
26	Colorless fluid	8.4	Fluid, hermit crab	8.0	Dark greenish yellow	5.6

C. Stomach Full.

2	Clam bait	8.0	Small shell fish	8.3	Dark green	5.4
15	Clam bait	6.6	Brown fluid, shell fish, lower in intest.	7.4 8.2 lower in intest.	—	—
1	Fish	7.1	—	6.8	—	—
5	Herring bait	6.4	Empty	7.4	Dark green	5.4
8	Herring, hermit crab	6.6	Snails, hermit crab	7.2 7.6 lower in intest.	—	—
3	Fish and snails	7.6	Empty	7.0	Light greenish yellow	4.7
4	Small clams, scallops and ascidians partially digested	8.4	Small shell fish partially digested	8.2	Light greenish yellow	6.3

Reaction in the Alimentary Tract of Living Eel-Pout with and without Forced Feeding.—To investigate further the reaction of the stomach a series of experiments was performed on living eel-pouts during periods of fasting and after forced feeding. In order to obtain a sample from the stomach without killing the fish, a long glass tube was inserted through the œsophagus and some of the contents sucked out. As this process involved considerable manipulation, causing a certain amount of injury to the animal, these experiments did not give the expected results. They confirmed, however, the findings on recently killed fish.

As it was thought possible that the reaction in the stomach might, to a certain extent, be determined by the food ingested, various substances such as clam, flounder and sea urchin were given in the forced feedings. The reactions of these foods differ somewhat, flounder flesh having a P_H of 6.8, clam P_H about 6.8 and ground-up sea urchin (including the shell) a P_H of 8.2.

The experiments of Tables I. and II. show that the reaction in the stomach of starved fishes as well as in fed animals is, as a rule, near the neutral point. It may, however, range slightly on either side of this point, the alkaline reaction even reaching a P_H of 8.5.

Two tentative explanations may be offered for this phenomenon. It is possible that the alkalinity of the gastric contents may be

due to the alkalinity of the food (shell fish), or it may be the result of the regurgitation of alkaline duodenal juices into the stomach. There is evidence for the latter suggestion, because in two instances the stomach contents showed a positive test for bile, this indicating the presence of duodenal juices.

The most striking fact, however, in all these experiments is that none of the food stuffs or even such a strong gastric stimulant as alcohol produced a high acidity in the stomach.

Table II.

P_H of Samples Taken from the Stomach of Living Eel-Pouts.

A. Without Feeding.

No. Fish.	Date.	Interval between Samples.	P_H.	Description of Sample.
7	July 29	0 hrs.	7.0	Clear watery.
		3 hrs.	7.0	Clear watery.
	July 30	18 hrs.	8.2	Mucus, slightly opaque.
		4 hrs.	7.4	Mucus, slightly opaque.
		18 hrs.	7.2	
17	Aug. 16	0 hrs.	8.5	Reddish brown fluid, sea urchin shell.
18	Aug. 16	0 hrs.	8.3	Reddish brown fluid.

B. Sea Urchin Fed.

23	Aug. 19	0 hrs.	7.2	Clear mucus.
		2 hrs.	Sea urchin fed P_H 8.2.	
		7 hrs.	8.0	Reddish fluid cont. sea urchin.
	Aug. 20	16 hrs.	7.0	Mucus.

C. Clam Fed.

6	July 27	0 hrs.	8.4	—
		17 hrs.	7.4	—
		7 hrs.	8.4	—
		17 hrs.	6.8	Mucus.
		Clam fed P_H 6.8.		
		4 hrs. later	5.8	Mucus.
		3 hrs.	7.6	—
12	Aug. 3	0 hrs.	7.0	Clear watery.
		24 hrs.	4.4	Gray mucus.
		Clam fed P_H 6.6.		
		3 hrs.	6.6	—
		16 hrs.	4.7	—
		5 hrs.	6.6	Died.

TABLE II. (*Continued*).

D. Flounder and Alcohol Fed.

No. Fish.	Date.	Interval between Samples.	P_H.	Description of Sample.
20	Aug. 20	0 hrs.	8.6	Clear fluid.
		1 hr.	Flounder fed P_H 6.8.	
		8 hrs.	8.0	Clear, contained pieces flounder.
	Aug. 21	16 hrs.	7.6	Clear.
	Aug. 22	48 hrs.	6.2	Clear.
	Aug. 24	48 hrs.	6.6	Clear.
		48 hrs.	10 cc. 10 per cent. alcohol fed P_H 6.6.	
		3 hrs.	6.6	—
21	Aug. 19	0 hrs.	6.4	
		1 hr.	Flounder fed P_H 6.8.	
		8 hrs.	6.6	—
	Aug. 20	16 hrs.	4.4	—
	Aug. 22	48 hrs.	6.4	—
	Aug. 24	48 hrs.	6.5	—
		48 hrs.	10 cc. 10 per cent. alcohol P_H 6.6.	
		1 hr.	7.4.	—
		1 hr.	7.4	—
		1 hr.	10 cc. 10 per cent. alcohol P_H 6.6.	
		1 hr.	7.2	—
		3 hrs.	6.4	—

E. Alcohol Fed.

24	Aug. 19	0 hrs.	6.2	
		2 hrs.	Fed sea urchin P_H 7.6.	
		7 hrs.	7.6	—
	Aug. 20	16 hrs.	6.4	Mucus clear.
	Aug. 22	24 hrs.	5.4	Mucus clear.
	Aug. 24	24 hrs.	7.8	Mucus clear.
		24 hrs.	Gave alcohol 10 cc. 10 per cent. P_H 6.8.	
		1 hr. 30 min.	8.0	
			Gave alcohol 10 cc. 10 per cent. P_H 6.8.	
		35 mins.	6.8	—
		3 hrs.	8.6	—
27	Aug.	0 hrs.	8.2	Yellowish fluid.
			Gave 10 cc. 10 per cent. alcohol P_H 6.8.	
		20 mins.	7.2	
		4 hrs.	8.0	

Reaction in the Alimentary Tract of Other Fishes.—The reaction of the stomach and duodenum of various fishes was investigated so that they could be compared with the eel-pouts. All the examined fishes, except fundulus, had a neutral or slightly acid reaction in the stomach during fasting, and a very high acidity during digestion, as is shown in the following table.

Table III.

Reaction of the Stomach, Duodenum and Bile in Various Fishes.

A. Stomach Empty.

Fish Specimen.	Stomach.		Duodenum.		Bile.
	Contents.	P_H.	Contents.	P_H.	P_H.
Skate (Barndoor).....	Empty	1.5 Cardiac 3.7 Pyloric	Empty	6.3 Duoden. 7.2 Intest.	—
(*a*) Fundulus	No stomach	—	Empty	7.1	7.0
(*b*)	No stomach	—	Empty	7.2	6.8
(*c*)	No stomach	—	Empty	7.4	7.0
(*a*) Flounder.	Empty	6.8	Empty	8.4	—
(*b*)	Empty	6.4	Empty	8.0	6.6
Haddock.....	Empty	6.2	Full small shell fish	6.7	6.4
Herring.....	Empty	6.8	Empty	7.0	5.8
Lump fish....	Empty	4.0	Empty	8.6	—
Sculpin.....	Empty	7.4	Empty	—	5.8

B. Stomach Full.

Skate.....	Full herring bait (beginning of digestion)	5.2 Cardiac 5.5 Pyloric	Full herring bait	6.3 Duoden. 7.2 Intest.	5.6
Skate.....	Full herring (partially digested)	2.8	Fluid	4.6	5.8
Lump fish....	Digesting food	2.8	Digesting food	8.2	—
Sculpin.....	Full fish (digesting)	2.2	Fluid	8.4	5.4
Sculpin.....	Full herring bait (digesting)	2.8	Digesting food	7.4 Duoden. 8.2 Intest.	5.6

It will be seen, on comparison of the above table with Tables I. and II., that the gastric digestion of the eel-pout presents certain pecularities, being different from the usual type of acid gastric digestion in fishes. Since there are fishes deprived of a stomach (*e.g.*, the family of Cyprinidæ, *Fundulus*, etc.) the question arises as to whether the eel-pout possesses an organ which is capable of secreting pepsin-hydrochloric acid. From an anatomical point of view, there is no doubt that the eel-pout possesses a structure corresponding to a stomach. Although this diverticulum is rather small, it cannot be considered as part of duodenum, for it is separated from it by a sphincter. Further evidence for this lies in the fact that the common bile and pancreatic duct enters the duodenum just below this sphincter.

As no histological examination could be made of the microscopic structure of the glands in the mucous membrane of the stomach, further investigation was restricted to a study of the digestive enzymes in the gastric and duodenal contents, and in extracts made from different parts of the alimentary canal.

Digestive Enzymes in Extracts of the Stomach, Duodenum and Liver of the Eel-Pout.—In Table IV., three typical experiments are quoted to show the amylolytic, lipolytic and proteolytic action of differently prepared extracts of the gastric and duodenal mucous membrane and of the liver. A number of other experiments gave analogous results.

As may be seen from Table IV., the presence of a lipase was demonstrated in the extracts of the liver and in the mucous membrane of the stomach and duodenum of the eel-pout. The activity of this enzyme was most pronounced in the alcoholic liver extracts, which were frequently strong enough to produce a P_H change from 8.0 to 7.0 in 1 hour and 30 minutes; compared with this, its action in the stomach is somewhat weaker, 4 hours being the average time taken to produce the desired change in reaction. The lipolytic enzyme of the duodenum is the weakest of the three, since it is usually one or more hours slower in its action than that of the stomach.

The strongest amylase was found in the extracts of the mucous membrane of the duodenum, which gave values as high as .6 per cent. with the Folin-Wu method. On the other hand extracts of the stomach had a very weak, if any, amylolytic action, .12 per cent. being the highest figure obtained. As the liver extract itself was found to contain glucose, the high values procured in the sugar determination are useless. There is, however, some slight evidence for the presence of an amylase in the liver because in several of the experiments there is an indication of a color change in the starch following the addition of iodine.

The range of the Folin-Wu method is from .07–.4 per cent. In the cases where the values obtained are higher than .4 the solution had been previously diluted so as to come in the correct range. The value obtained was then multiplied by the dilution. Controls done on soluble starch without extracts gave an average value of .076 per cent.

TABLE IV.

ENZYMES IN EXTRACTS OF THE MUCOUS MEMBRANE OF THE STOMACH, DUODENUM AND LIVER.

Date.	No. Fish.	Part Dig. Tract Used for Extracts.	Amylase.	Lipase.	Protease.
Aug. 5	13	Stomach, alcohol ext.	2 cc. starch + 4 drops ext. 1 dy. iodine reac.—blue. 2 dys. iodine reac.—blue. 2 dys. sugar deter. .091% −. Boiled control = .069% −.	3 drops ext. + buffer at P_H 8.0. Went to P_H 7.0 +. Control P_H 8.0 −.	1. fib. + 15 drops ext. at P_H 1.6 −. 2. fib., 15 drops ext. at P_H 6.0 −. 3. fib., 15 drops ext. at P_H 8.0 −. 3 days no digestion.
		Duodenum, alcohol ext.	2 cc. starch + 4 drops ext. 1 dy. iodine reac.—blue. 2 dys. iodine reac.—light blue. 2 dys. sugar deter. = .60% +.	3 drops ext. + buffer at P_H 8.0. 7 hrs. went to P_H 7.0 +. 7 hrs. control P_H 8.0 −.	1. same as above, P_H 1.6 +. 2. same as above 15, P_H 6.0 −. 3. same as above 15, P_H 8.0 −. 3 dys. Nos. 2 and 3, no diges. 3 dys. No. 1 digested.
		Liver, alcohol ext.	2 cc. starch + 2 drops ext. 2 dys. iodine reac.—blue. Sugar deter. useless, as liver ext. cont. sugar.	3 drops ext. + buffer at P_H 8.0. 7 hrs. went to P_H 7.0 +. 7 hrs. control P_H 8.0 −.	1. same as above, P_H 1.6 −. 2. same as above, P_H 6.0 −. 3. same as above, P_H 8.0 −. 3 dys., no digestion.
8	14	Stomach, glycerol ext.	2 cc. starch + 2 drops ext. 1 dy. iodine reac.—blue. 2 dys. iodine reac.—blue. 2 dys. sugar deter. = .08% −. Boiled control = .03% −.	3 drops ext. + buffer at P_H 7.0. 3 dys. went to P_H 7.0. (Glycerol ext. not good for lipase).	1. fib., 5 drops ext. 20 drops H_2O, P_H 1.6 +. 2. fib. and same, P_H 6.0 −. 3. fib. and same, P_H 8.0 −. 1 dy. Nos. 2 and 3, no diges. 1 dy. No. 1, digested.
		Duodenum, glycerol ext.	2 cc. starch + 2 drops ext. 1 dy. iodine reac.—blue. 2 dys. iodine reac.—light blue. 2 dys. sugar deter. = .20% −. Boiled control = .04% −.	3 drops ext. + buffer at P_H 8.0. 3 dys. went to P_H 7.0.	1. same as above, P_H 1.6 −. 2. same as above, P_H 6.0 −. 3. same as above, P_H 8.0 −. 3 dys., no digestion.

TABLE IV. (*Continued*).

Date.	No. Fish.	Part Dig. Tract Used for Extracts.	Amylase.	Lipase.	Protease.
18	19	Stomach, HCl ext.	No amylase in HCl ext.	No lipase in HCl ext.	1. fib. + 10 drops ext., 10 drops H_2O, P_H 2.0 −. 2. fib. same boiled. 10 drops H_2O, P_H 2.0 −. 3 dys., no digestion.
		Duodenum, alcohol ext.	2 cc. starch + 4 drops ext. 1 dy. iodine reac.—blue. 2 dys. iodine reac.—very pale. 2 dys. sugar deter. = .23% +. 2 dys. boiled control = .08% −.	3 drops ext. + buffer at P_H 8.0. 3 hrs. went to P_H 7.0 +. 3 hrs. control P_H 8.0 −.	1. fib. + 15 drops ext., 10 drops H_2O, 2.0 −. 2. fib. same, P_H 6.0 −. 3. fib. same, P_H 8.0 −. 3 dys., no digestion.
		Liver, alcohol ext.	2 cc. starch + 4 drops ext. 2 dys. iodine reac.—blue. Sugar deter. useless.	3 drops ext. + buffer at P_H 8.0. $1\frac{1}{2}$ hrs. went to P_H 7.0 +. $1\frac{1}{2}$ hrs. control P_H 8.0 −.	1. fib. + 15 drops ext., 15 drops H_2O, P_H 2 −. 2. fib. same, P_H 6.0 −. 3. fib. same, P_H 8.0 −. 3 dys., no digestion.

\+ at end of line means digestion.

− at end of line means no digestion.

There is no proteolytic enzyme in the extracts of the liver or of the duodenum, but occasionally such a one was found in the extracts of the stomach. This enzyme could be extracted with glycerol only, and acted slowly, in a very acid medium P_H 1.6–2.0. Since there is no difficulty whatever in obtaining pepsin from the mucous membrane of fishes possessing an acid gastric digestion, by means of such extracting substances as glycerol, .36 per cent. to .4 per cent. HCl or even distilled water (Kenyon) (5), the results quoted in this investigation are worthy of attention. The conclusion must be drawn that the acid-peptic digestion does not play an important part in the alimentary canal of the eel-pout. Even if an acid gastric juice is secreted its pepsin has very little chance to act either in the stomach or the duodenum. This is clear from the fact that the usual range of P_H in the stomach of the eel-pout is from 6.4 to 8.2; in a few instances only, it was found to be as low as 4.0 to 4.4 (Table II). The reaction in the duodenum is always on the alkaline side.

Further experiments dealing with the estimation of digestive enzymes in the juices taken from the stomach and intestine of various eel-pouts lend a strong support to the above view.

One may see from Table V. that in the juice taken from the stomach of a number of animals a very strong proteolytic enzyme was found which digested fibrin at a P_H 6.4 to 8.2. This enzyme could not be extracted either from the gastric or duodenal mucous membranes. A possible explanation of this phenomenon is the assumption that the pancreatic juice regurgitates from the duodenum and continues its action in the stomach.

Discussion.

The gastric digestion in the eel-pout presents marked peculiarities. Although a protein-digesting enzyme could be extracted from the gastric mucous membrane, it appears that it cannot play a great part in gastric digestion. The evidence for this is as follows: This proteolytic enzyme is not easily extracted by the usual methods, which is an indication that the mucous membrane is not rich in its contents. It seems, however, to be a true digestive enzyme, because it is active at a P_H 1.6 to

Table V.

Digestive Enzymes in the Juice Taken from the Stomach and Intestine of the Eel-pout.

Fish No.	Juice Taken from	Amylase.	Lipase.	Protease.
15	Stomach	2 cc. 5% starch, 5 drops juice. 1 dy. iod. test—pale lavender. 1 dy. sugar deter. .66% ++.	3 drops ext. buffer at P_H 8.0. Over night passed P_H 7.0 ++.	Juice and fibrin. 5 hrs. all digested, P_H 6.4 ++.
	Duodenum	2 cc. 5% starch, 5 drops juice. 1 dy. iod. test—colorless. 1 dy. sugar deter. .83% ++.	3 drops ext. buffer at P_H 8.0. Over night went to P_H 7.0 +.	Juice and fibrin. 5 hrs. all digested, P_H 6.4 ++.
17	Stomach	——	——	Juice and fibrin (P_H 8.5). $4\frac{1}{4}$ hrs. all digested (P_H 7.2) ++.
18	Stomach	——	——	Juice and fibrin (P_H juice 8.3). 4 hrs. all digested (P_H 6.6) ++.
25	Duodenum	——	——	Juice and fibrin (P_H juice 8.2). 2 hrs. all digested (P_H at 8.2) +++.
26	Stomach	4 cc. 5% starch, 12 drops gastric juice. 1 dy. sugar deter. .15% +.	3 drops ext. buffer at P_H 8.0. 18 hrs. went to P_H 7.0 +.	Juice and fibrin (P_H juice 8.4). $1\frac{3}{4}$ hr. all digested (P_H at 7.4) +++.
	Intestine (below duod.)	4 cc. 5% starch, 12 drops juice. 1 dy. sugar deter. .40% +.	3 drops ext. buffer at P_H 8.0 24 hrs. still at P_H 8.0 −.	Juice and fibrin (P_H juice 8.0). 12 hrs. all digested +.

Remark.—Glycerol extracts were made of the stomach and duodenum of fish No. 15; no proteolytic enzyme was present in the duodenal extract and in the extract of the stomach fibrin was digested only at a P_H 2.0, and not at a P_H 6.0 or 8.0, though the juice from the stomach readily digested fibrin at P_H 6.4.

2.0, while the autolytic enzyme of a type of pepsin is destroyed at a P_H of 2.6 (Bradley) (6). Moreover, the action of this enzyme on such an easily digestible substrate as fibrin is rather weak.

Further evidence that the proteolytic enzyme is not important in gastric digestion lies in the fact that only occasionally was the reaction of the stomach found to be acid enough (P_H 4.0–5.8) to allow a pepsin-like enzyme to act. According to McFarlane (7) the range of activity for pepsin is from a P_H of 0.5 to 6.5.

These facts show that if peptic digestion takes place in the stomach of the eel-pout it plays a subordinate or secondary part. The protein substances in the food of this animal are digested chiefly by the trypsin of the pancreatic juice, which probably regurgitates into the stomach.

It would be highly interesting to perform a histological examination of the gastric mucous membrane of the eel-pout to determine whether the peptic glands are fully developed as to both number and structure.

Summary.

1. The eel-pout has a true anatomical stomach. The common bile and pancreatic duct opens into the duodenum below the pyloric sphincter.

2. The reaction of the stomach in both fasting and fed animals is near the neutral point, ranging from a P_H of 6.5 to 8.4. The reaction in the duodenum is slightly alkaline.

3. The extracts of the stomach possess a strong lipase, a very weak amylase and a pepsin-like enzyme, digesting at a P_H of 1.2. The duodenal extracts, on the other hand, have a strong amylase, a lipase and no protease. Liver extracts had a marked lipolytic action, but contained no protease.

4. Digestive juices removed from both the stomach and duodenum of eel-pouts had a lipase, amylase and a very strong proteolytic enzyme, digesting at a P_H near the neutral point.

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